NAS 1.12/7:400-402
Eos SAR, A Key Component of...

THE EARTH OBSERVING SYSTEM

SYNTHETIC APERTURE RADAR

Eos SAR

A Key Component of the Mission to Planet Earth

P90-0276

Climate and Hydrologic Systems

Biogeochemical Dynamics

Ecological Systems and Dynamics

Solid Earth Processes

OUR CHANGING PLANET: OBSERVING GLOBAL CHANGE

The dramatic rises in population and industrialization during the past century have prompted concerns that the health of our planet is threatened. Symptoms of this deteriorating health include the increased levels of greenhouse gases, ozone depletion, desertification, deforestation, soil erosion, air- and water-quality deterioration, and changing biological patterns.

Advances within the past two decades have demonstrated the capabilities of observing the Earth from space. This perspective is critical for studying the components of the whole Earth system—atmosphere, ocean, land surface, ice and snow cover, and living organisms. Understanding the interactions between these components (for example, land–atmosphere or atmosphere–ocean) is also vitally important.

The Earth Observing System (Eos) is the first significant step in the United States Global Change Program's plan to address the environmental issues mentioned above. The Eos Synthetic Aperture Radar (Eos SAR), which is a key instrument in the overall Eos program, is designed to monitor the following processes:

- Forest biomass and global deforestation and their impact on increasing carbon dioxide (CO_2)
- Soil, snow, and canopy moisture and flood inundation and their relationship to the global hydrologic cycle
- Polar ice properties and their impact on polar heat flux

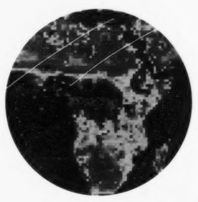
The Eos SAR will provide day and night images, through the clouds, of the Earth's surface—thus allowing continuous and reliable monitoring throughout the annual cycles. The instrument will provide global coverage, every three to five days, at 250-meter resolution; it will also provide local and regional coverage at resolutions as fine as 25 meters. The Eos SAR is currently planned as a dedicated mission that, along with the Eos-A and Eos-B missions, forms the Eos elements of the Mission to Planet Earth.

GLOBAL WARMING AND THE CARBON CYCLE

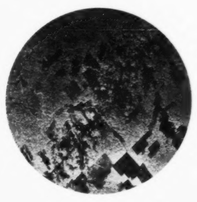
Atmospheric carbon dioxide (CO_2) flux from deforestation is a key unknown parameter in understanding the carbon cycle and its contribution to global warming. Unknown parameters include the areal extent of forests and the rate of deforestation (measurable with a single channel radar) and the biomass of existing forests (measurable only with a multichannel radar).

Over the first 10–20 years of their development, forests achieve a maximum leaf area index, allowing the trees to intercept the maximum amount of sunlight required for growth. This development, however, shields the lower canopy from optical sensors. After maximum leaf deployment, which makes up about 90% of the forest's total biomass, forest growth continues in the trunks and branches. Only the longer wavelengths of the Eos SAR can penetrate this upper canopy and sense the forest biomass.

The other major unknown parameter in the carbon cycle is the amount of carbon taken up in the ocean by phytoplankton; this parameter will be measured by the Moderate Resolution Imaging Spectrometer (MODIS) on Eos-A. Thus, long-term global imaging with both MODIS and the Eos SAR is vital to the understanding of global warming.



Desertification



Deforestation

ENERGY BALANCE AND POLAR ICE MAPPING

Through its ability to observe the spatial coverage of polar ice and glaciers—and with its fine-scale measurement of sea ice motion, ice type and concentration, and ice edge configuration—the Eos SAR is a key instrument for determining significant changes in the ice environment, including ice dynamics, heat flux, and bottom water formation. All of these measurements are important for modeling the global climate, energy balance, and ocean circulation, and for monitoring ocean–atmosphere–cryosphere interactions.

In addition, knowledge of the nature of thin sea ice, as measured by the Eos SAR along with the High Resolution Microwave Spectrometer Sounder (HIMSS), will help assess the magnitude of global warming. Because of cloud cover and poor lighting conditions over the polar regions, the radar, with its reliable global coverage capability, is essential to this monitoring capability. Several key algorithms, including ice motion and ice classification, have already been implemented and will be operational at the Alaska SAR Facility (ASF) in preparation for the Earth Resources Satellite (ERS-1) mission.

Polar Ice

Hydrology

HYDROLOGICAL AND GEOPHYSICAL PROCESSES

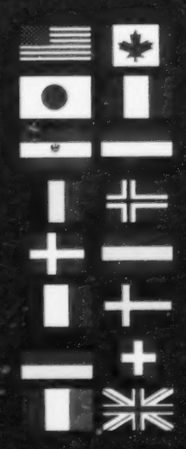
Understanding the global hydrologic cycle is essential because this cycle plays a role in nearly every biological process on Earth. Two key components, soil moisture and snow-water content, have been historically difficult to measure with remote-sensing instruments. Passive microwave sensors can estimate snow-water content, but only for light snow cover. For alpine snowpacks, SAR is needed.

New advances using multipolarization radar techniques indicate that soil and vegetation moisture can be measured independently. Thus, the Eos SAR, which features multipolarization, is the only satellite instrument with the potential to measure soil moisture.

Plate motions and mountain-building processes over the last few million years have created topographic barriers to atmosphere–ocean circulation and have set the stage for multiple ice ages. A history of Earth's past climates and diverse dynamic surface processes is preserved in the geologic record. The evolution of high mountain ranges such as the Andes influences atmospheric circulation patterns and provides a unique record of climatic change over the years. In addition, active processes such as erupting volcanoes affect the land surface—they represent significant forcing functions on atmospheric chemistry and short-term climate. The Eos SAR will contribute to the analysis of volcanic and other plate-motion and mountain-building processes via the interferometric measurement of volcano topography and the monitoring of the rate of change in landscape morphology.

AN INTERNATIONAL ENDEAVOR

The Eos SAR is the key element in a sequence of Earth-sensing radar systems provided by the international scientific community beginning in 1991. The Eos SAR will combine, for the first time, the multifrequency, multipolarization capabilities for quantitative measurement of geophysical and biophysical parameters (biomass, soil moisture) with long-duration global monitoring. Precursor missions include the European Space Agency's (ESA's) Earth Resources Satellite (ERS-1) and Canada's RADARSAT, both designed for the observation of surface features important for the global environment; Japan's Earth Remote Sensing Satellite (JERS-1), dedicated to geologic mapping, and the United States' shuttle-based Space Radar Laboratory (SRL). These missions will not only provide critical data for Eos SAR-algorithm development, but will also provide the essential long-term databases required for monitoring decadal changes.



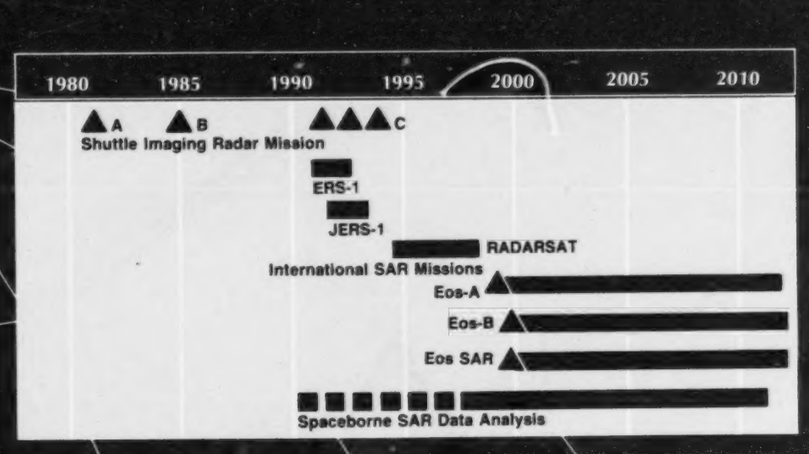
The SRL mission carries the Shuttle Imaging Radar-C/X-Synthetic Aperture Radar (SIR-C/X-SAR) instrument, which was built through the cooperative efforts of the United States, the Federal Republic of Germany, and Italy. SIR-C/X-SAR will test the multifrequency, multipolarization algorithms that are being developed to monitor biomass, soil moisture, and other parameters; it will also test the tools needed to interpret Eos SAR data.

The data systems essential for managing the vast amount of information required for global observation are already being developed. Protocols that exist on data format and accessibility will be used with radar-satellite data from the international community. The data products generated by the Eos SAR will be archived in the Eos Data and Information System (Eos DIS) and will be made available to the international community for cooperative scientific investigations and operational environmental monitoring requirements.

Eos SAR: A PLAN FOR ACTION

Since 1982, the Eos SAR had been planned as a key instrument on the Eos-B polar platform. To reduce platform configuration costs, however, the SAR was moved to a dedicated spacecraft in 1989. The cost of flying the SAR was thus significantly reduced. Although it was not included in the 1991 Eos New Start, the SAR scientifically remains an integral part of the Eos mission. Its proposed launch, coincident with Eos-A, is essential to the study of global carbon, hydrologic, and energy cycles.

The National Aeronautics and Space Administration (NASA) plans to initiate development of the Eos SAR within a few years of the Eos-A and Eos-B New Starts. The goal is to acquire overlapping 15-year data sets with both Eos-A and the Eos SAR.



For further information, contact:
NASA Headquarters (Code EE), Washington, D.C. 20546

NASA
National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

JPL 400-402 2/90